



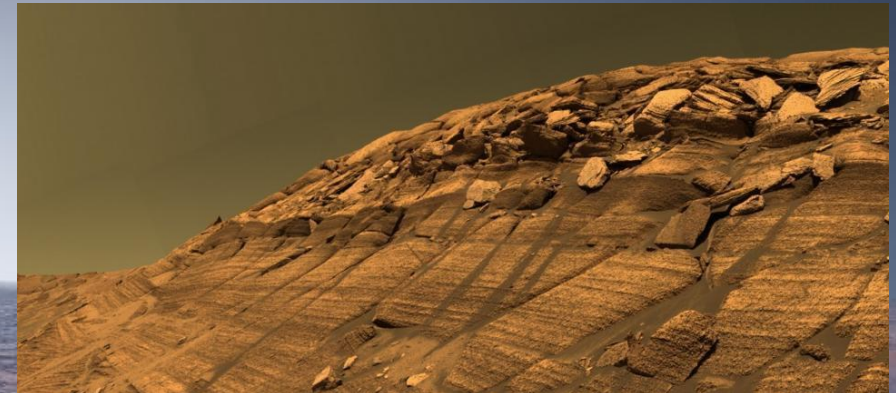
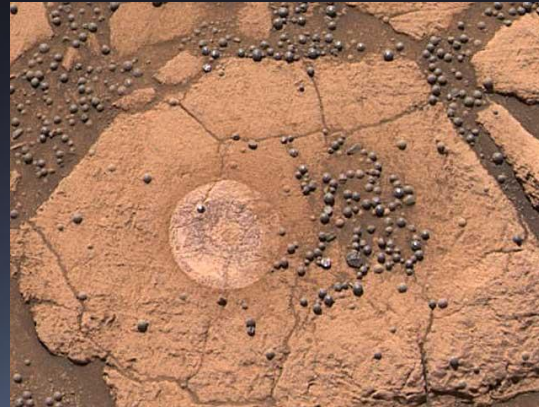
InSight

The first mission to thoroughly
study the deep interior of Mars

© 2018 California Institute of Technology
Government sponsorship acknowledged

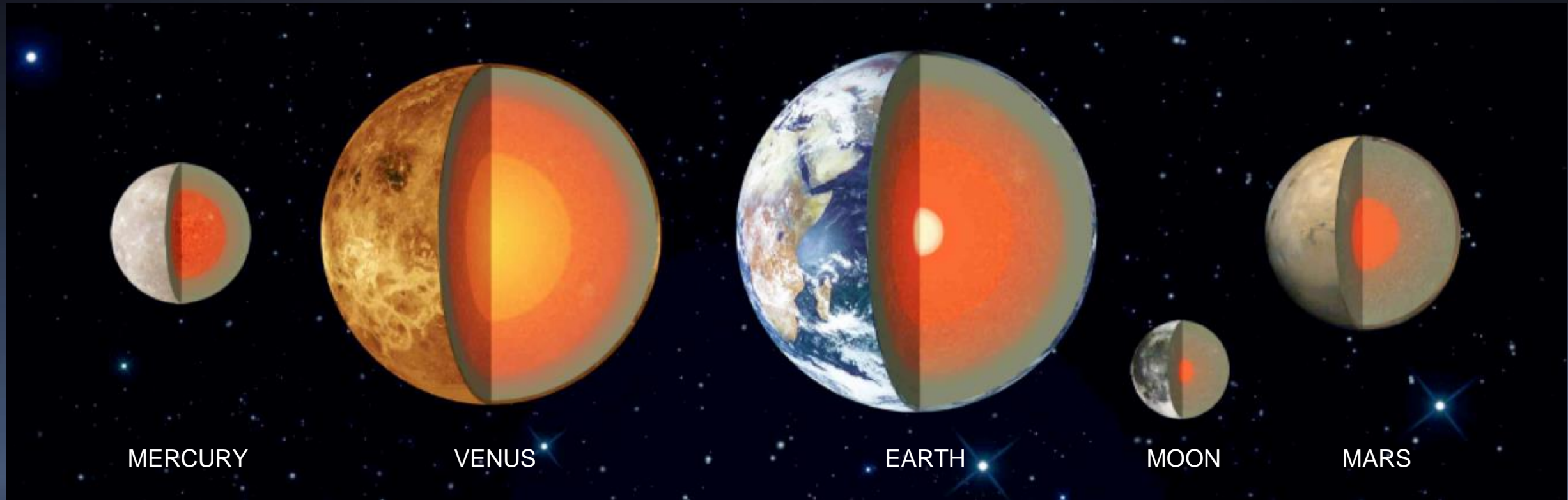
Troy Lee Hudson
Jet Propulsion Laboratory, California Institute of Technology

Previous missions have investigated the surface of Mars.



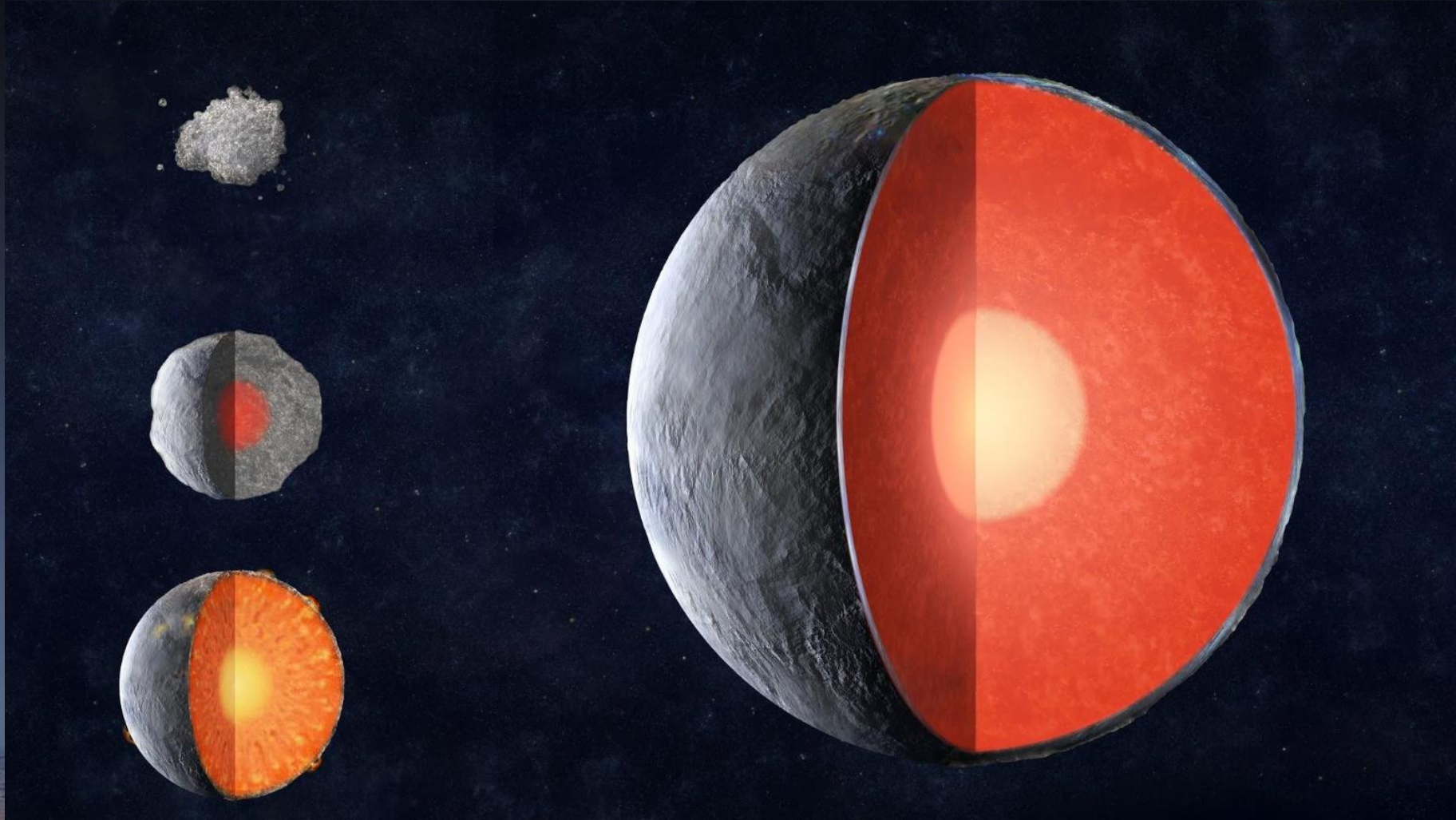
But we still have questions about how Mars formed and evolved.

Did all rocky planets form from the same stuff?



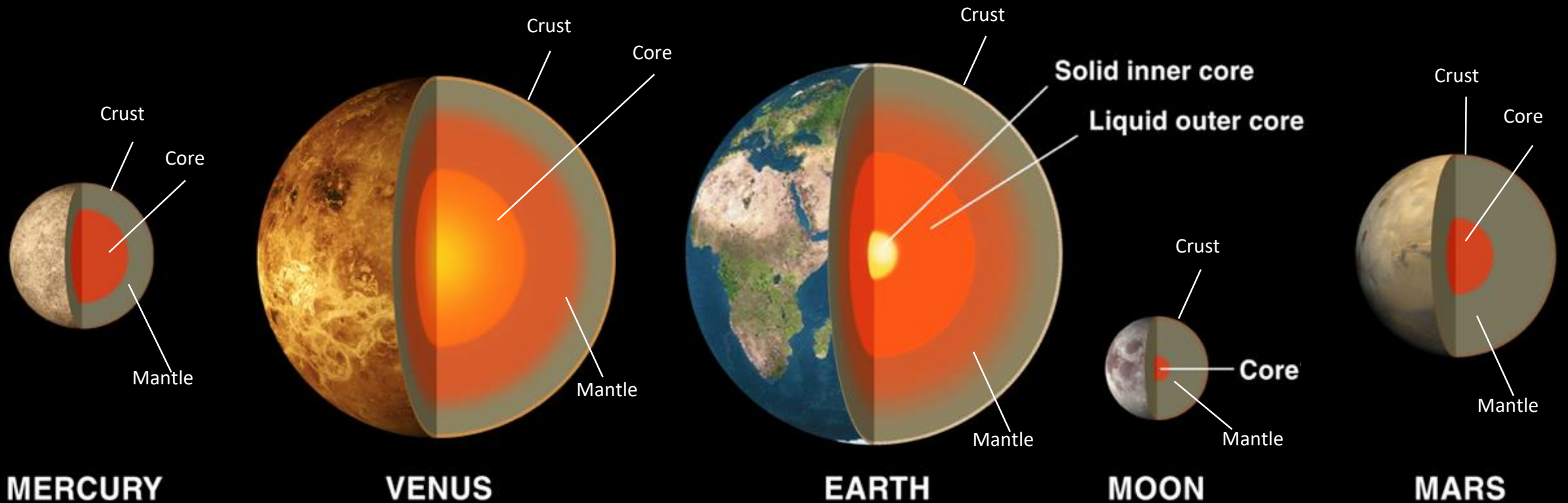
How did they change over 4.5 billion years?

As a planet forms, it collects more material and grows larger.



Scientists believe all the rocky planets formed via this same process.

More than just a Mars mission: InSight's findings will tell us more about how ALL the rocky planets of the solar system formed.



Img: Lunar and Planetary Institute

We know Earth and the Moon pretty well.



←
100+ years of terrestrial
seismology and geology

→
Apollo seismometers
(1969-1977) and returned
rock samples



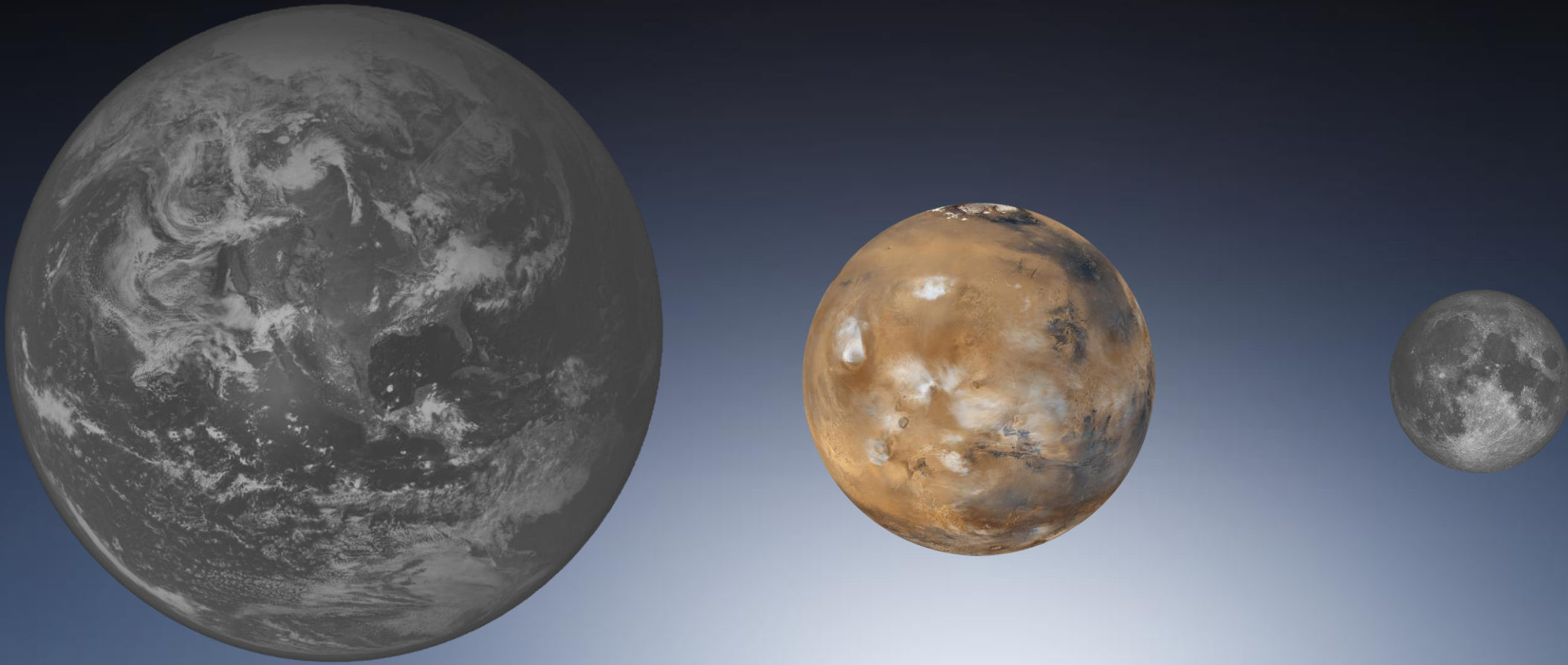
Warm: liquid outer core → magnetic field

Active: volcanoes, earthquakes, plate tectonics

Cold: solid throughout,
remnant magnetism

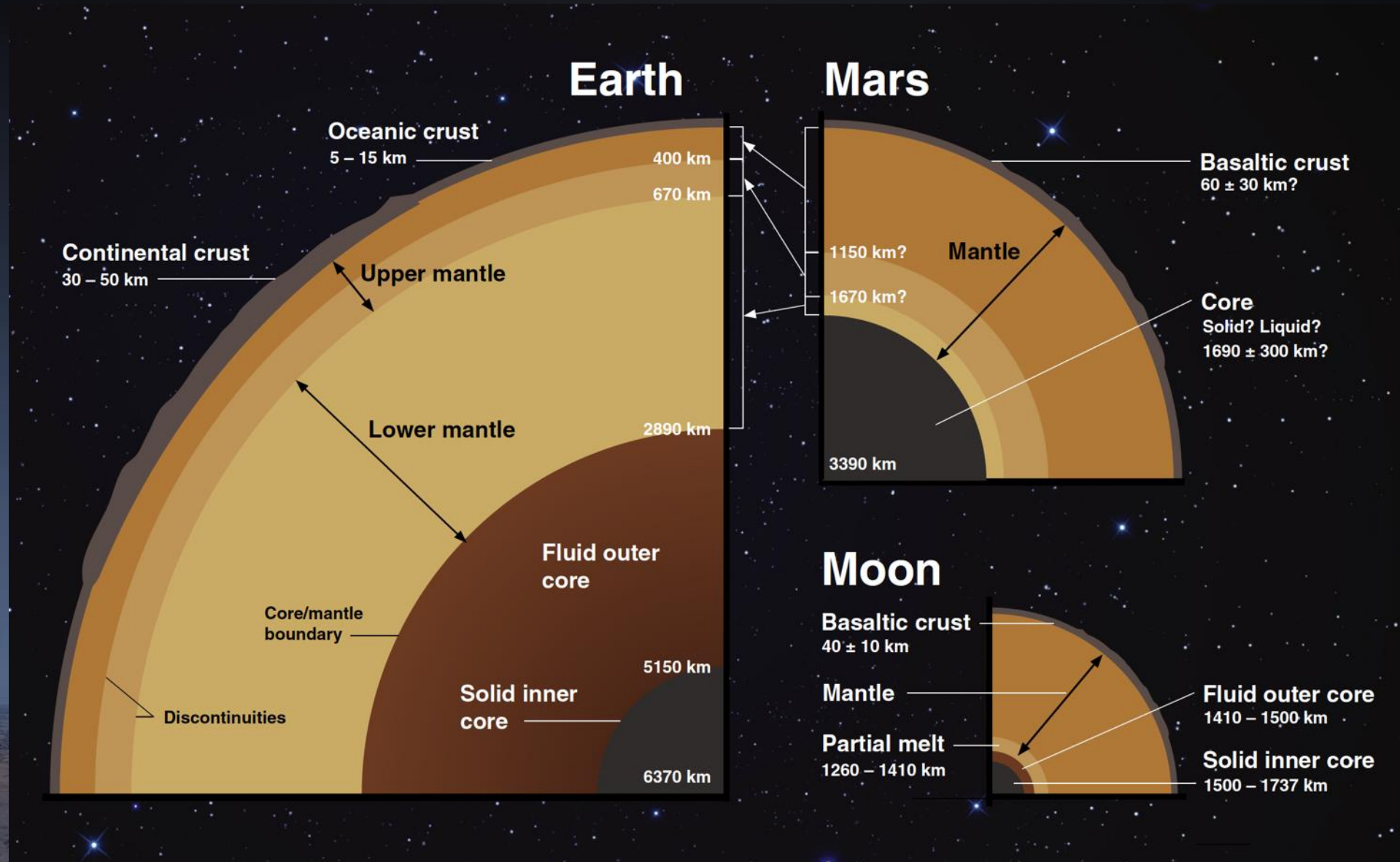
Quiet: most activity in the past

Mars is an ideal in-between.



**Big enough to have experienced a very active history;
but small enough to lose its early heat and 'freeze'.**

We haven't looked deep inside Mars yet, so we have lots of questions.





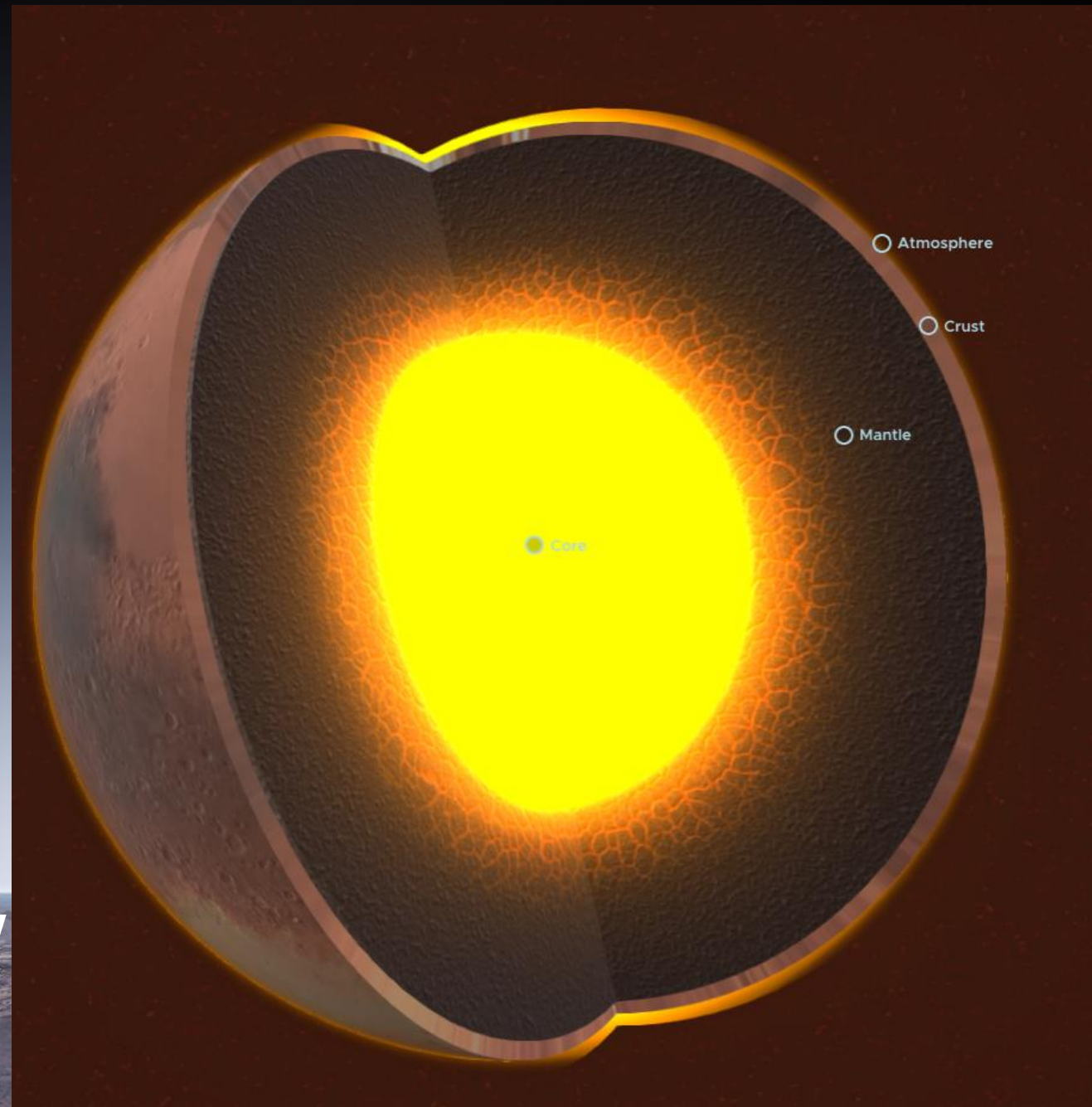
Vital signs: windows into the deep interior of Mars

- ☐ **Structure – Marsquakes**
- ☐ **Temperature – Heat Flow**
- ☐ **Reflexes – Rotation and Wobble**

These provide a peek into how all rocky planets form!

InSight Science Goals:

- ❑ The size of the core; its composition; and its state (liquid, solid, or partially dissolved)
- ❑ The thickness and structure of the crust
- ❑ The structure of the mantle and its composition
- ❑ How warm the interior is and how much heat is still flowing out

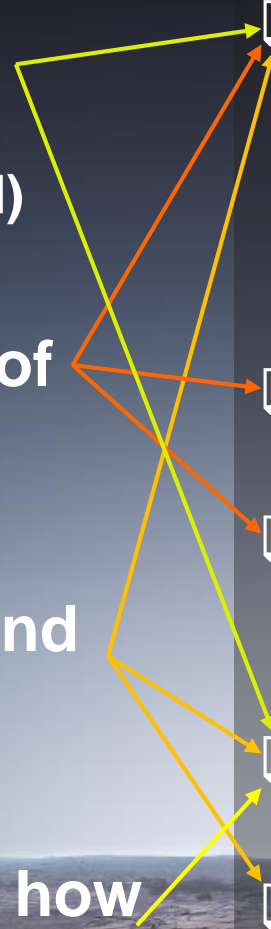


InSight Science Goals:

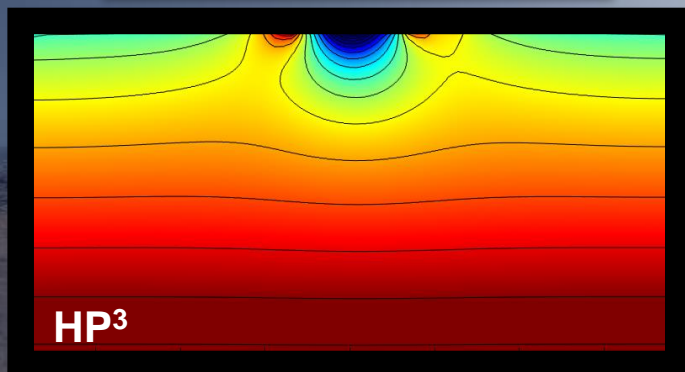
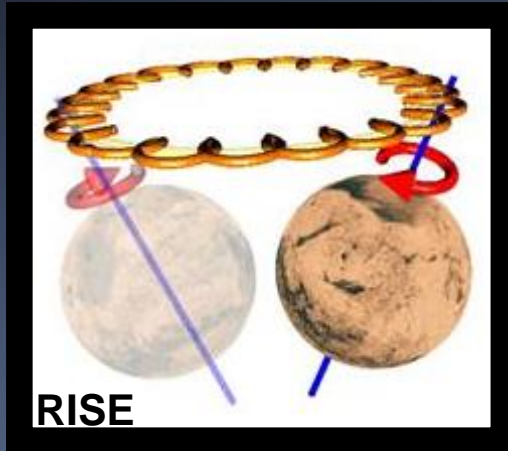
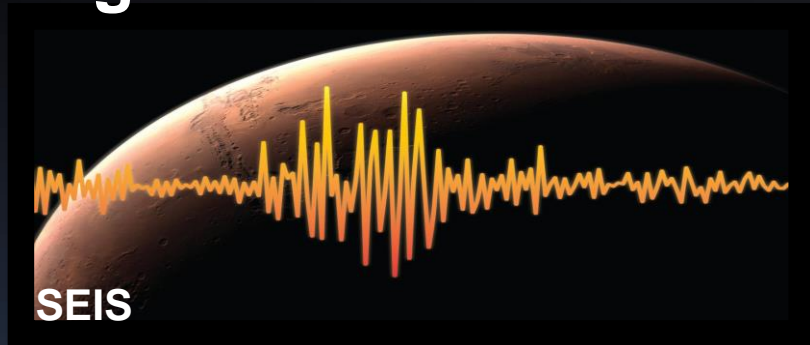
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InSight Measurements:

- ☐ How powerful and frequent internal seismic activity is on Mars, and where it is located within the structure of the planet
- ☐ How Mars reacts to meteorite impacts
- ☐ How the surface of Mars flexes as its moon Phobos passes overhead
- ☐ The spin rate and wobble of Mars
- ☐ The temperature profile with depth and the thermal properties of the ground



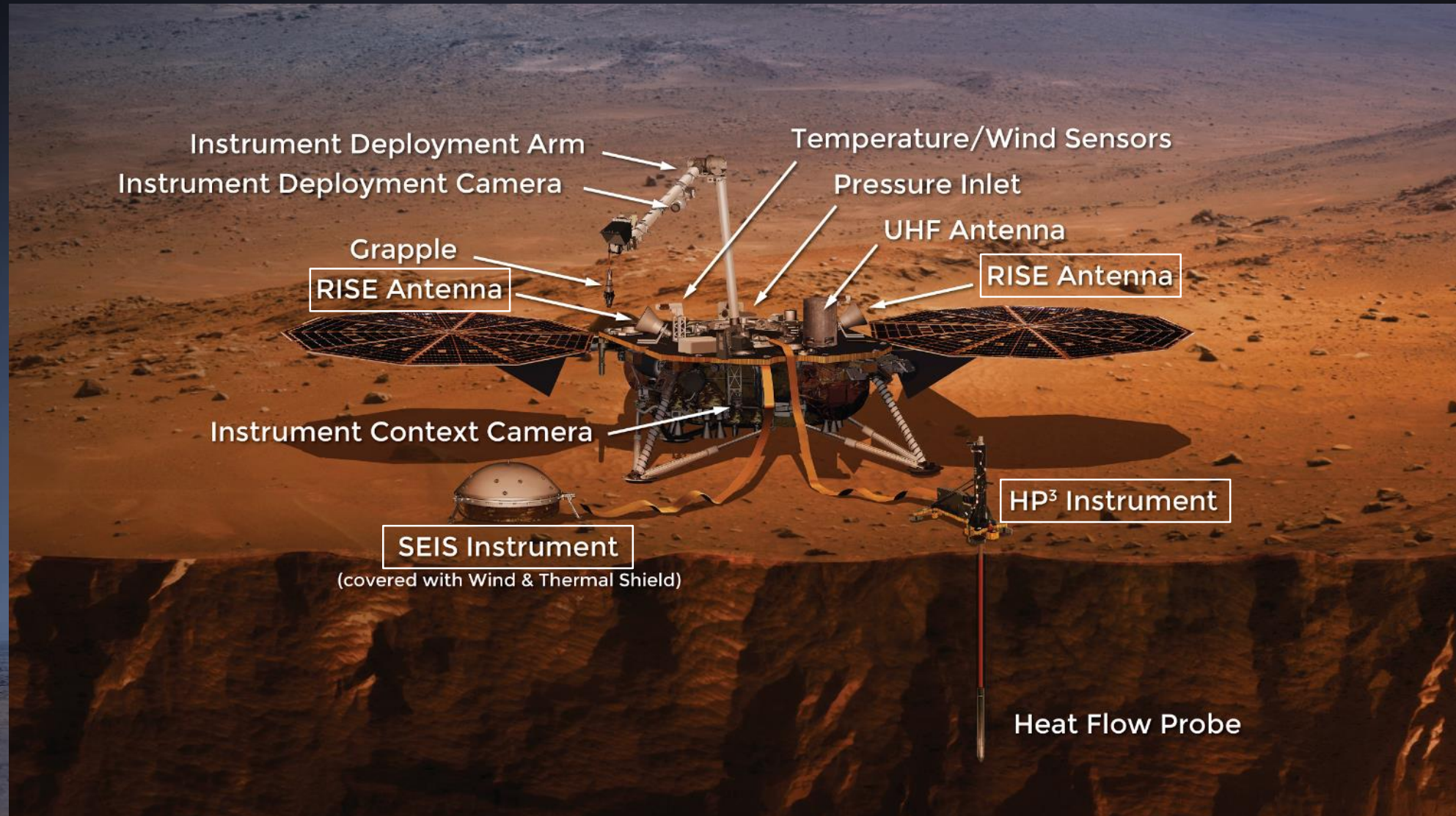
InSight Instruments:



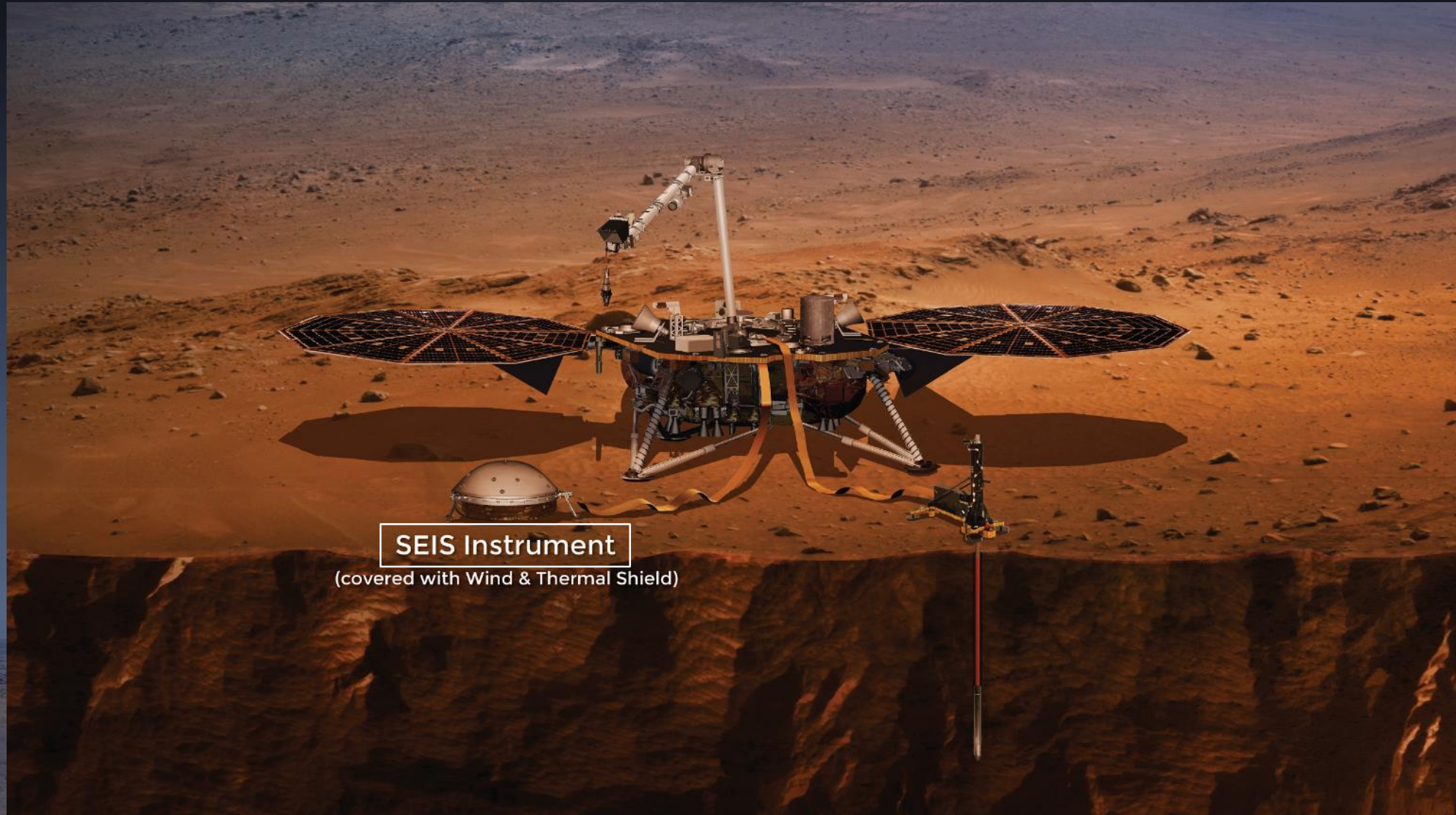
InSight Measurements:

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The lander has several tools dedicated to studying the deep interior of Mars.



InSight carries a seismometer to listen for marsquakes.

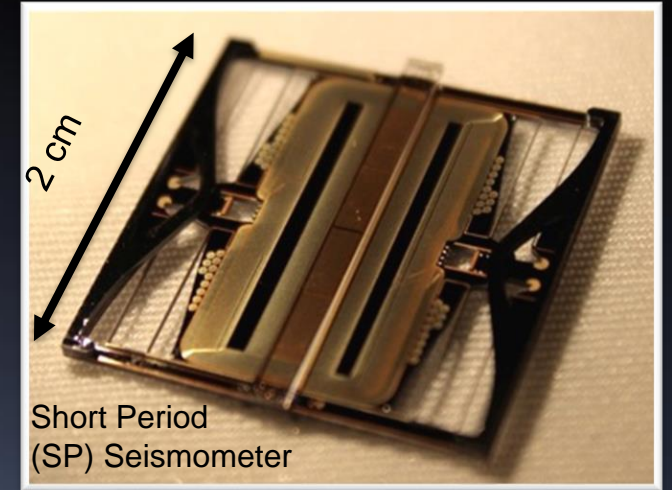
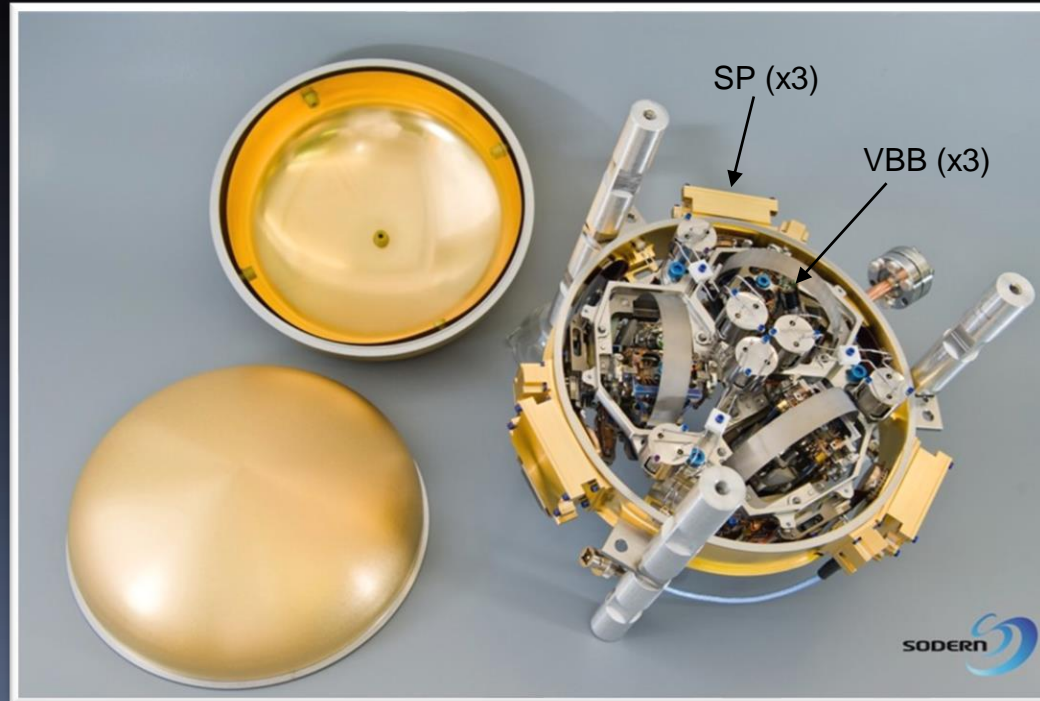
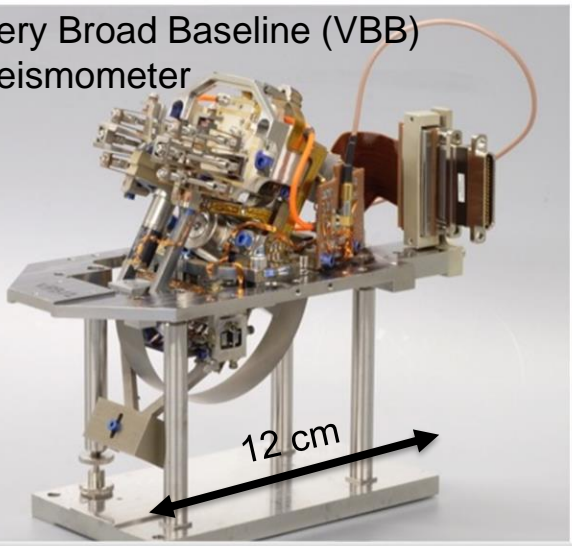


SEIS Instrument

(covered with Wind & Thermal Shield)

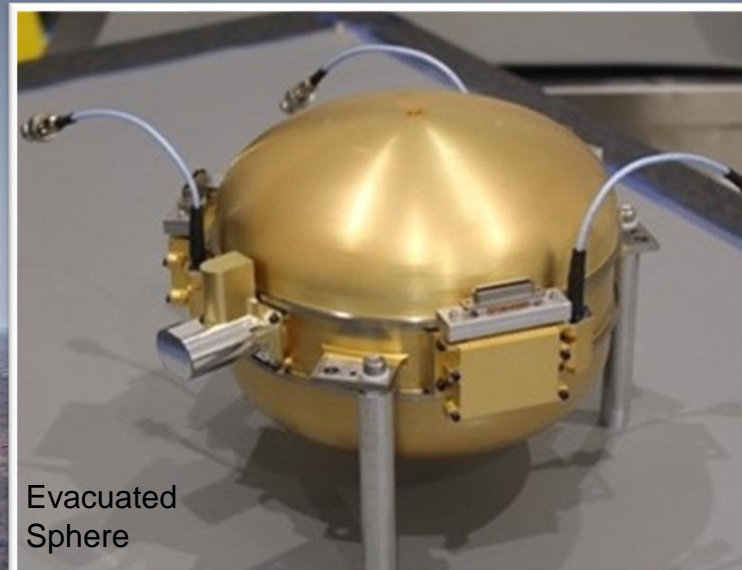
SEIS Instrument

Very Broad Baseline (VBB)
Seismometer

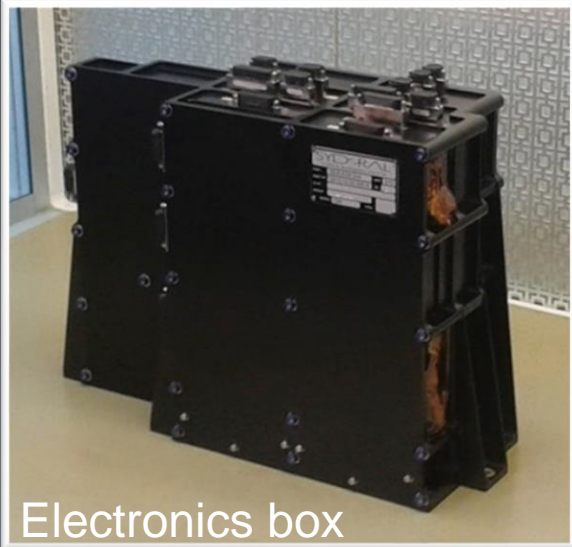


**SEIS is as good as
the best Earth-based
seismometers.**

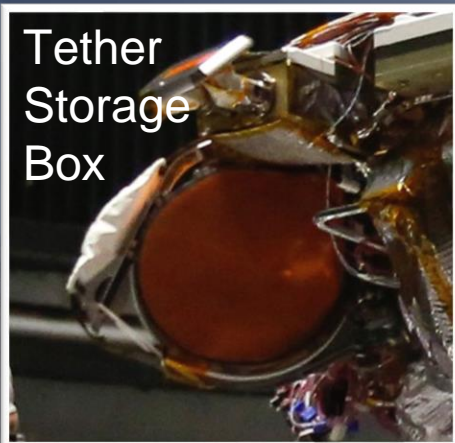
**It can measure
displacements
smaller than a
hydrogen atom!**



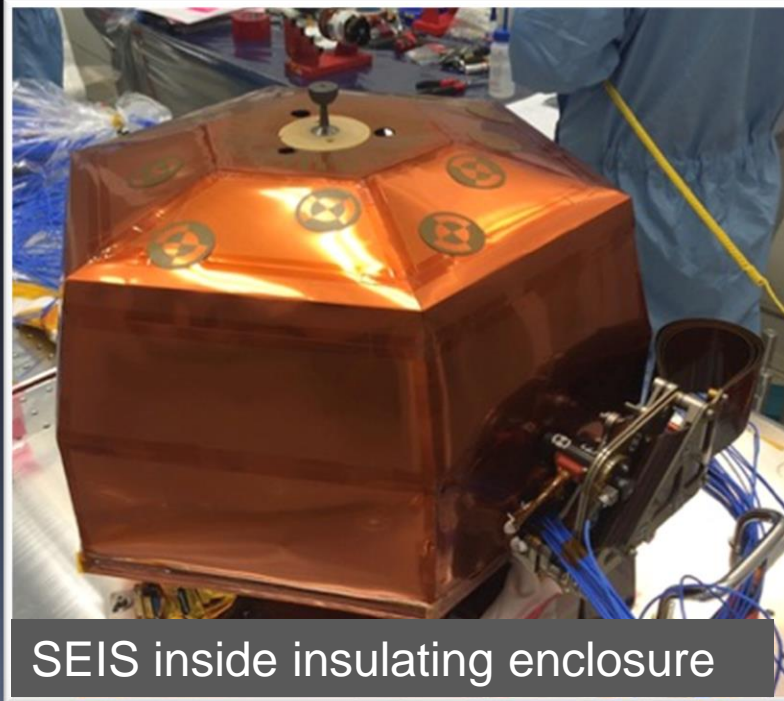
Other SEIS Components



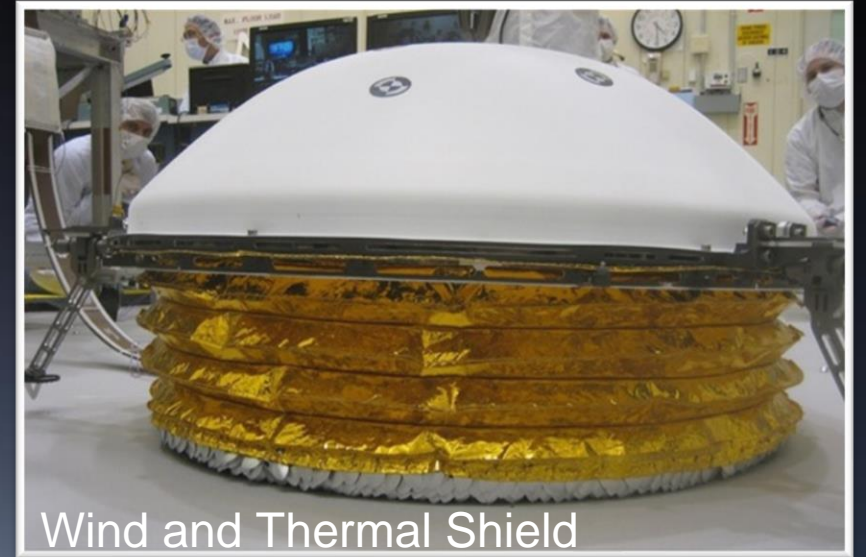
Electronics box



Tether
Storage
Box



SEIS inside insulating enclosure



Wind and Thermal Shield

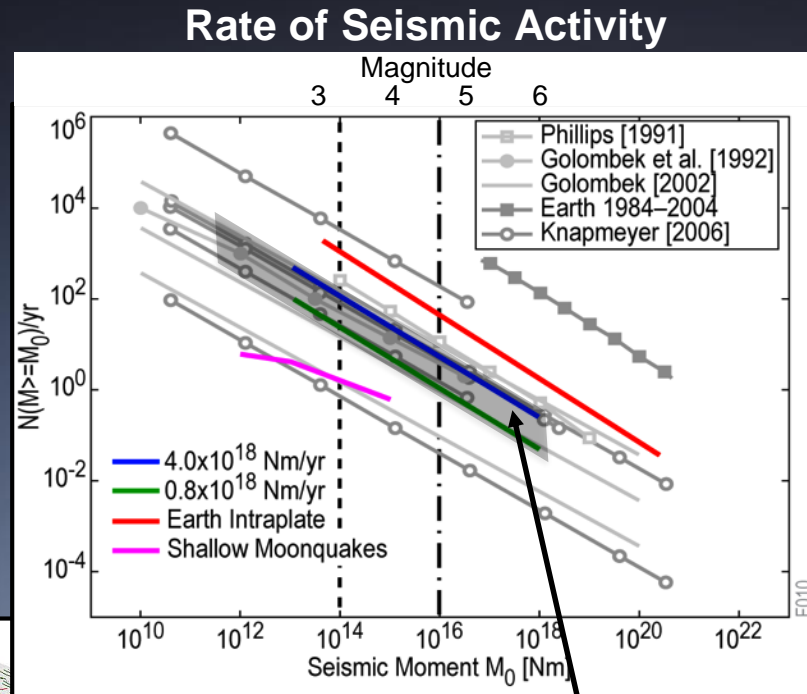
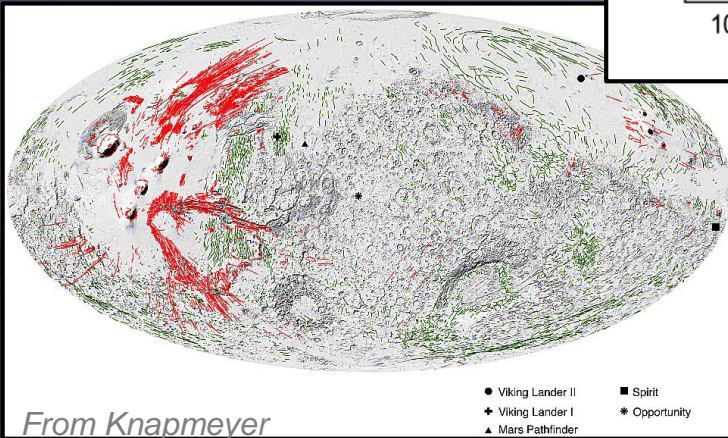


Tether

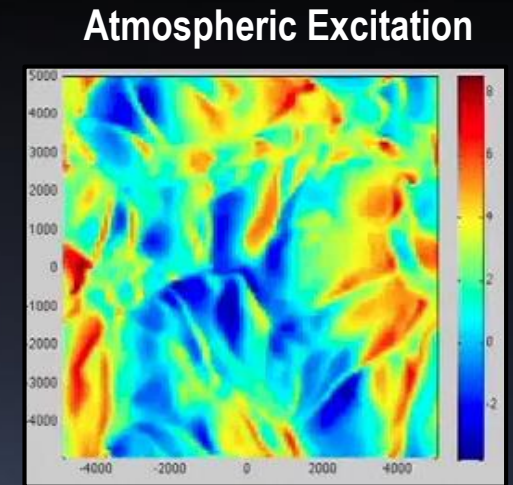
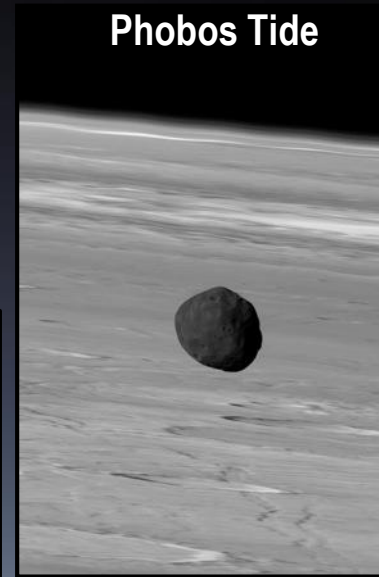
What causes seismic signals on Mars?



Faulting



Expected Range of Marsquakes



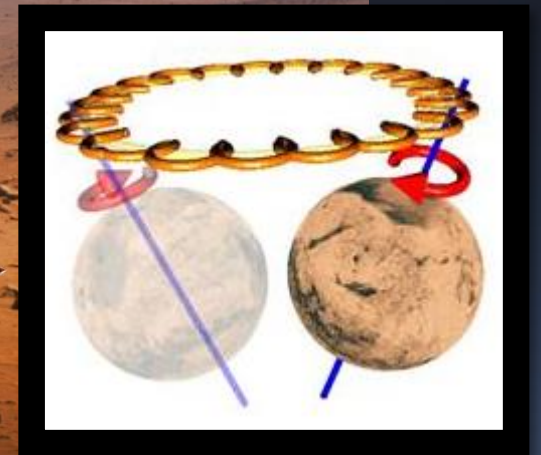
Meteorite Impacts



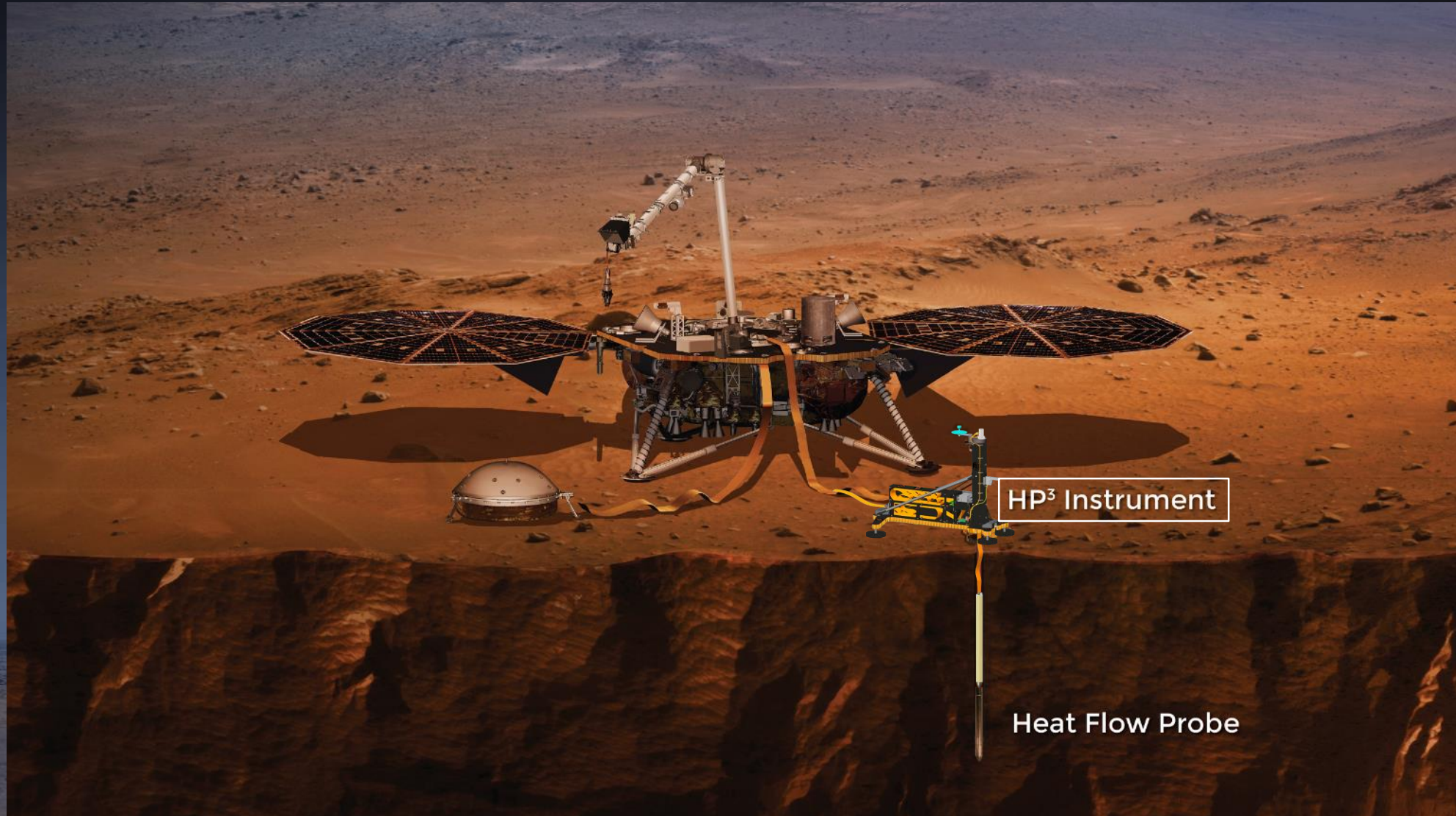
**SEIS measures arrival time, direction, and character of seismic waves.
InSight uses these to make better models of Mars' interior.**



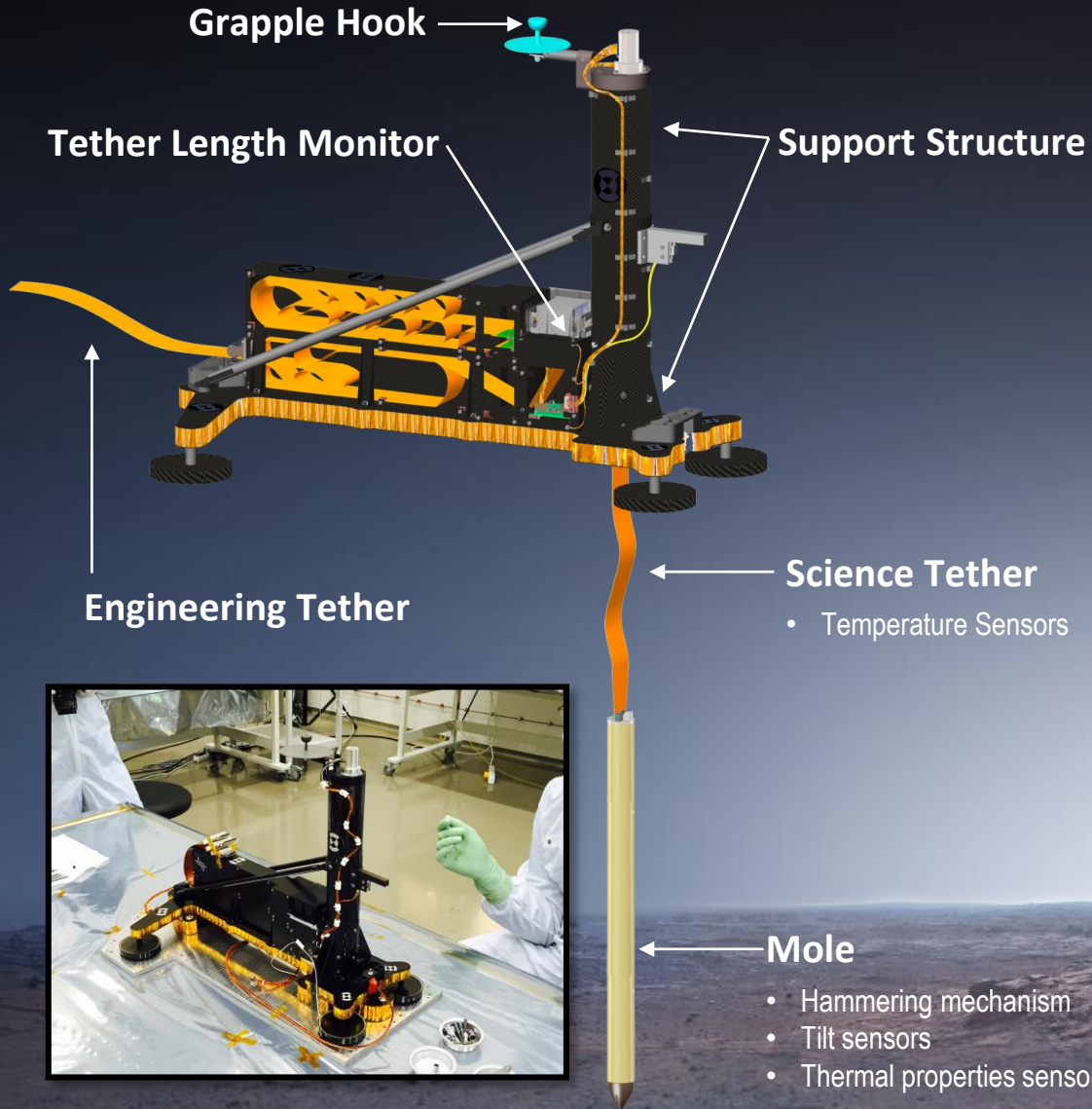
**InSight will test Mars' reflexes with RISE,
telling us about Mars' core.**



The Heat Flow and Physical Properties Package, HP³, will take Mars' temperature.



HP³ Instrument



HP³ measures **heat flow** to understand the chemical and thermal evolution of Mars

- ❑ Quantity of radioactive elements acquired during formation
- ❑ Thermal history of Mars
- ❑ Energy to drive present-day geologic activity

Heat flow is determined by measuring the **thermal conductivity** and the **thermal gradient** (change of temperature with depth).

Challenges:

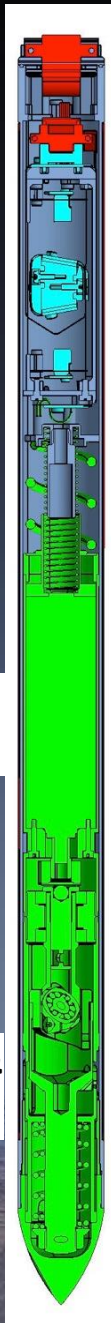
- ❑ Surface disturbances – need to get below for good data
- ❑ Deepest dig – deepest we've ever gone on any object besides Earth
- ❑ Small temperature differences – 0.01 degree accuracy

HP³ Mole

Tilt
Sensor

Motor &
Gearbox

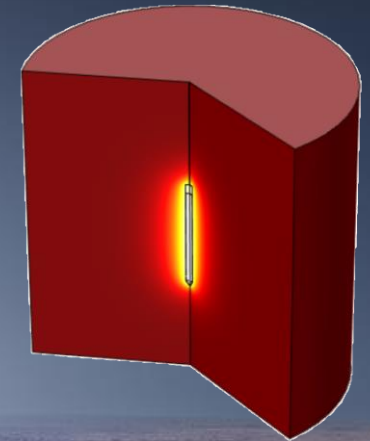
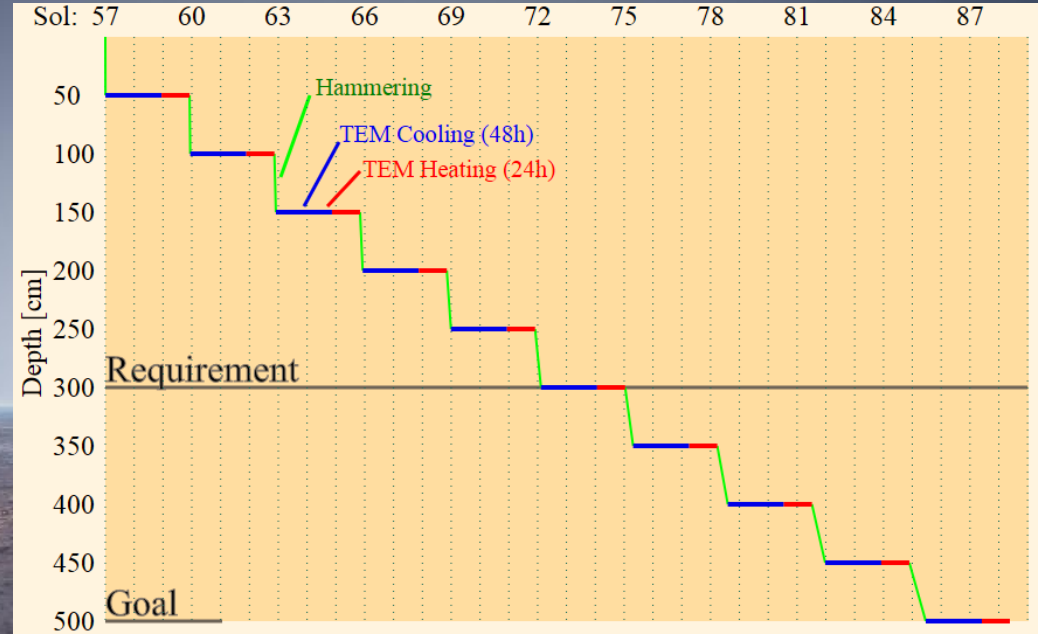
Springs &
Hammer



40 cm

HP³ mole makes slow and steady progress to 5 meters below the martian surface

- 3 seconds per hammer stroke
- 10 cycles: penetration, cool-down, and measurement
- 24 hours of slow heating to measure thermal properties
- 50 cm of additional depth each cycle
- 3 days between penetration cycles

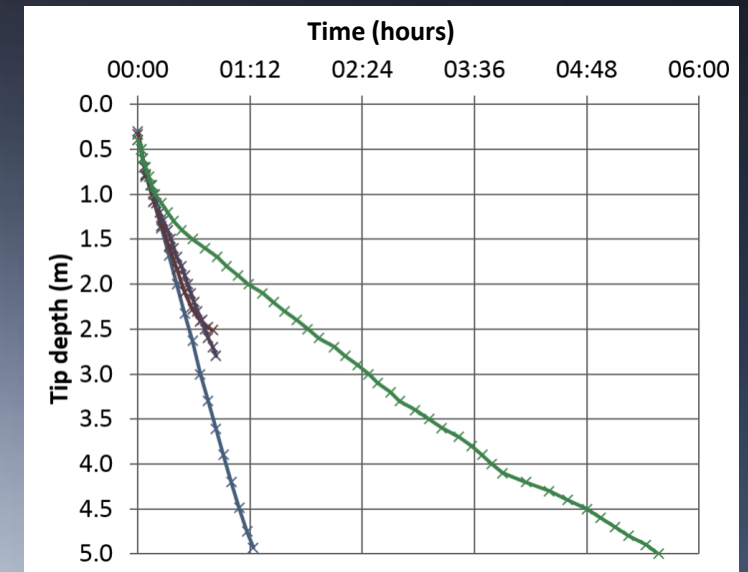


The mole heats up to measure subsurface thermal properties

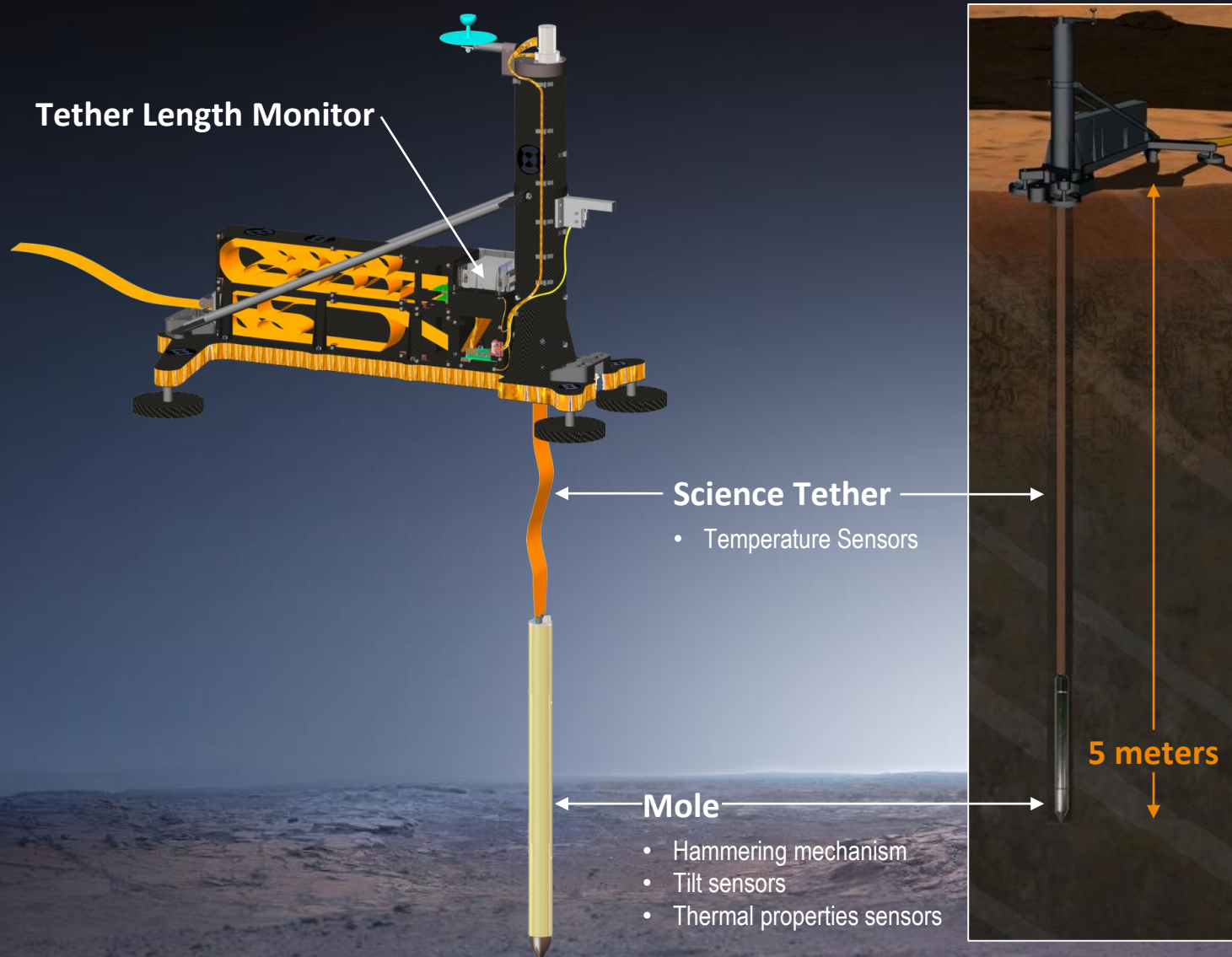


Timelapse of HP³ mole penetration to 5 meters in 5.5 hours!

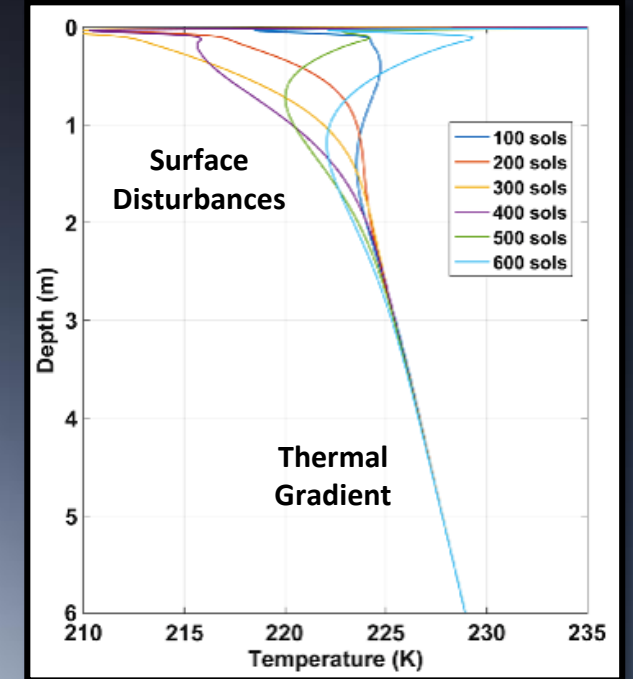
Tether is 36 mm wide
and marked with ink
every 5 cm



HP³ Monitors Subsurface Temperatures.

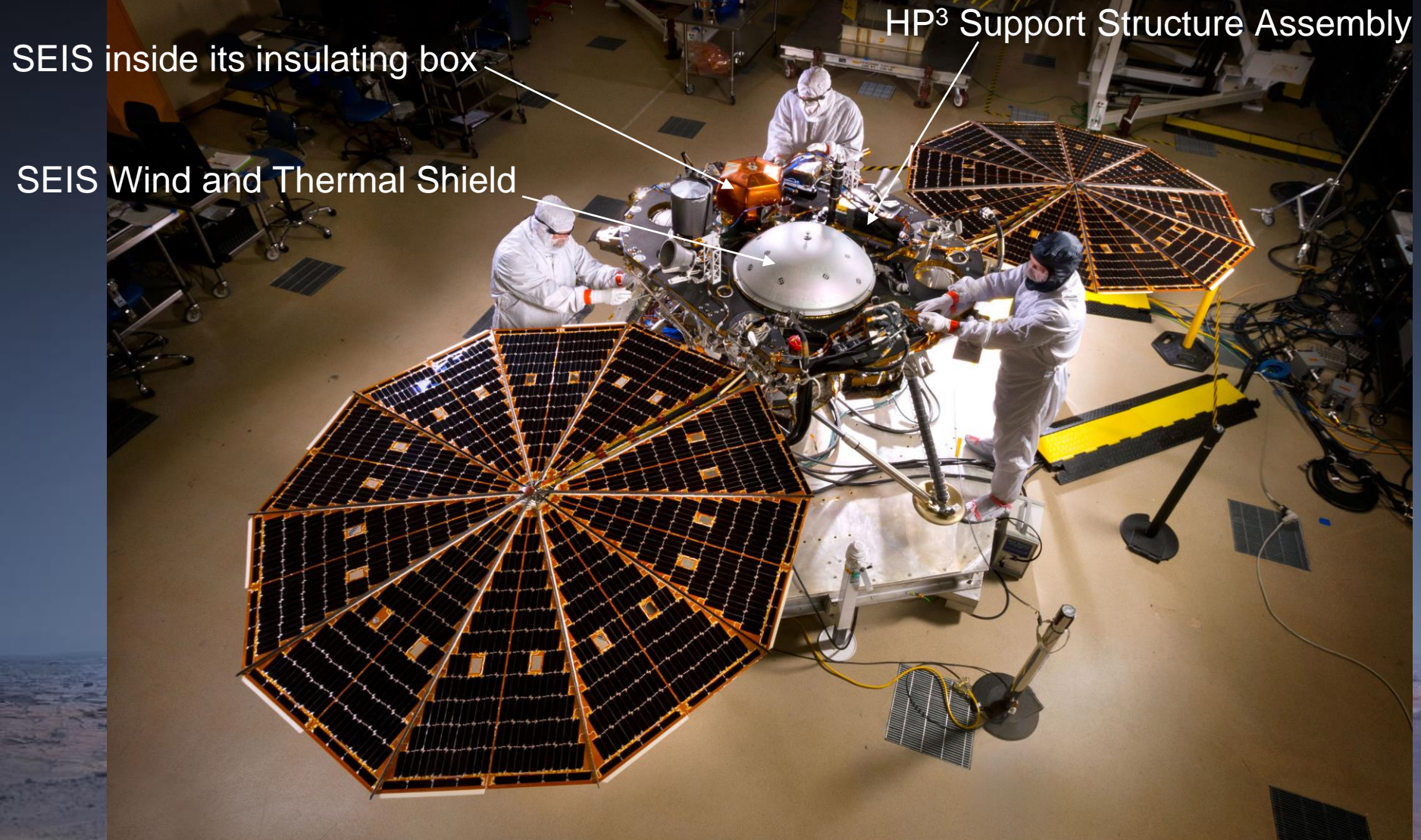


Temperature
Sensors in
Science
Tether



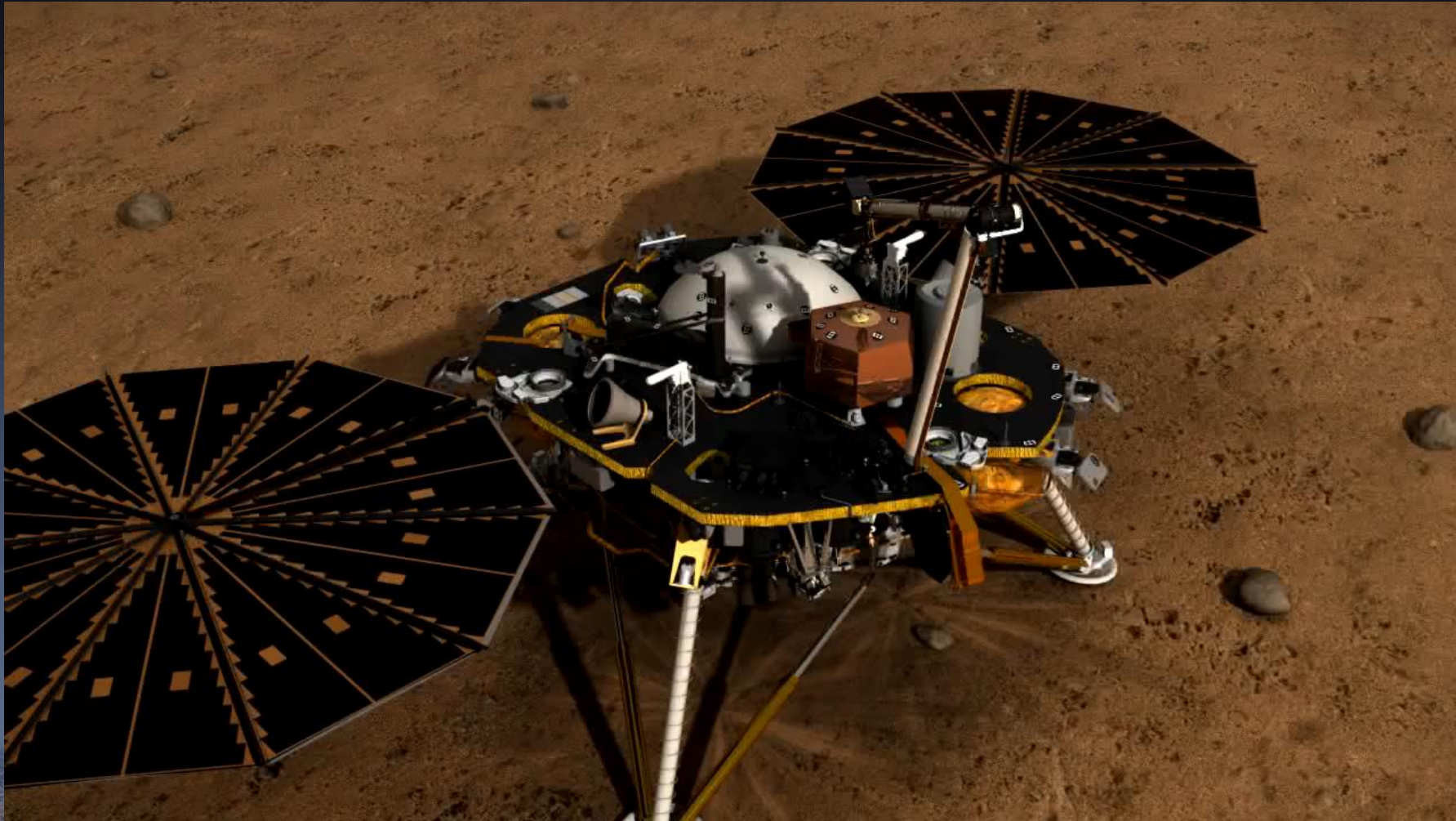
From Sigler et al., 2017

Upon InSight's arrival, SEIS and HP³ have one last journey to make.



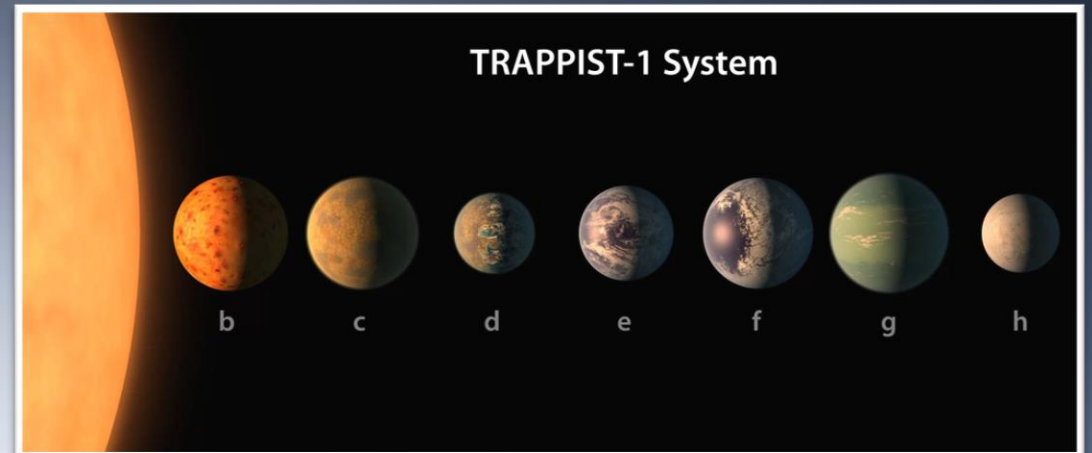
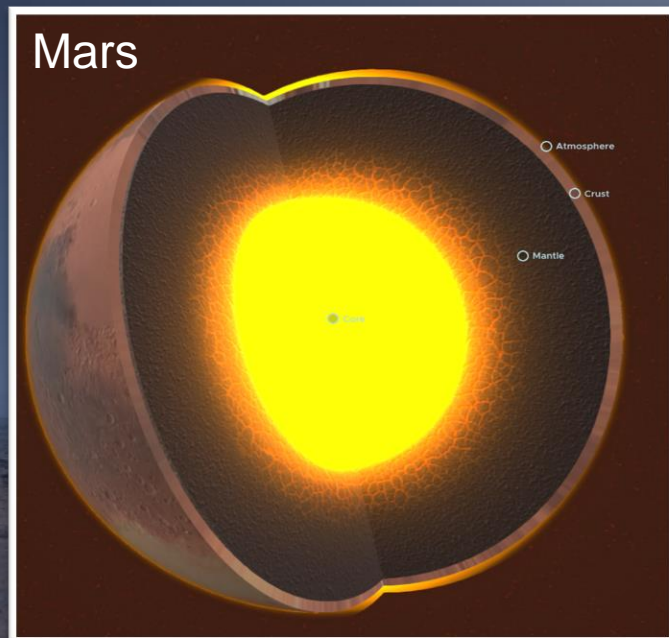
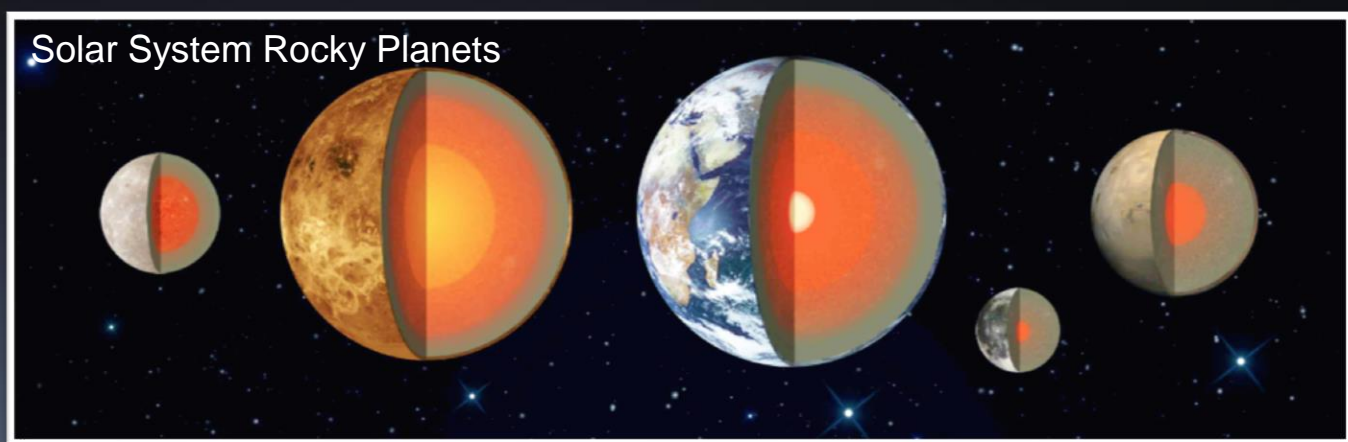
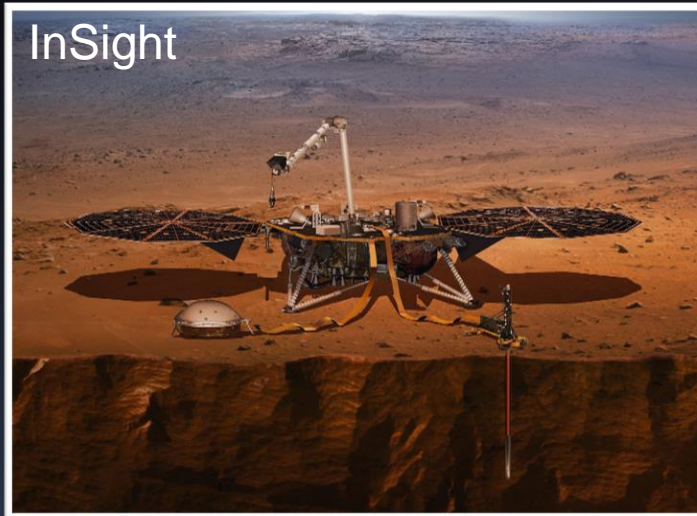
InSight has an arm to place instruments on the ground.

InSight has an arm to place instruments on the ground.



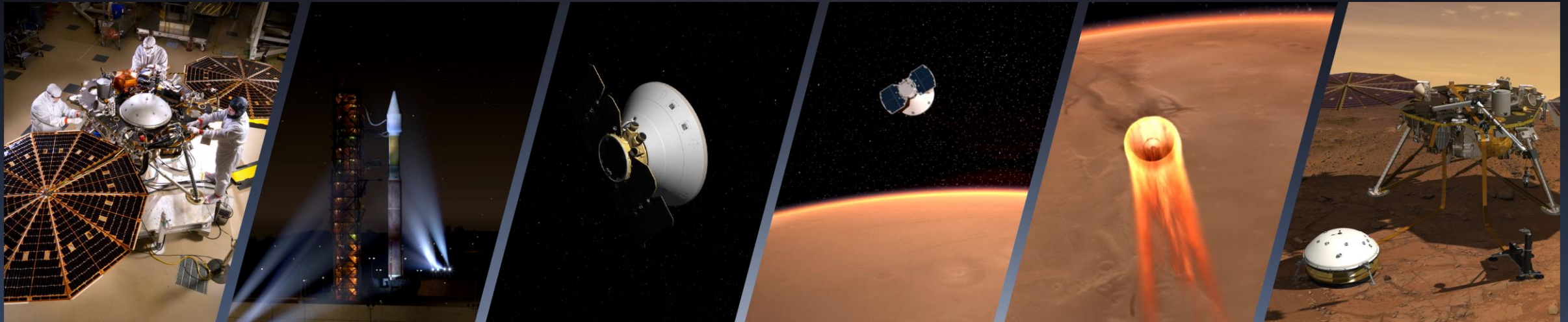
A seemingly simple task; but key to InSight's success.

More than just a Mars mission.



InSight's findings will tell us more about how ALL the rocky planets of the solar system formed. And will provide insight into their formation around other stars.

InSight Mission Timeline



**Building the
spacecraft -
Complete!**

**Launch
May to June 2018**

*Vandenberg AFB:
First interplanetary launch
from the west coast.*

**Cruise to Mars
Summer/ Fall 2018**

**Approach
towards Mars
Fall 2018**

**Landing on Mars
November 26,
2018**

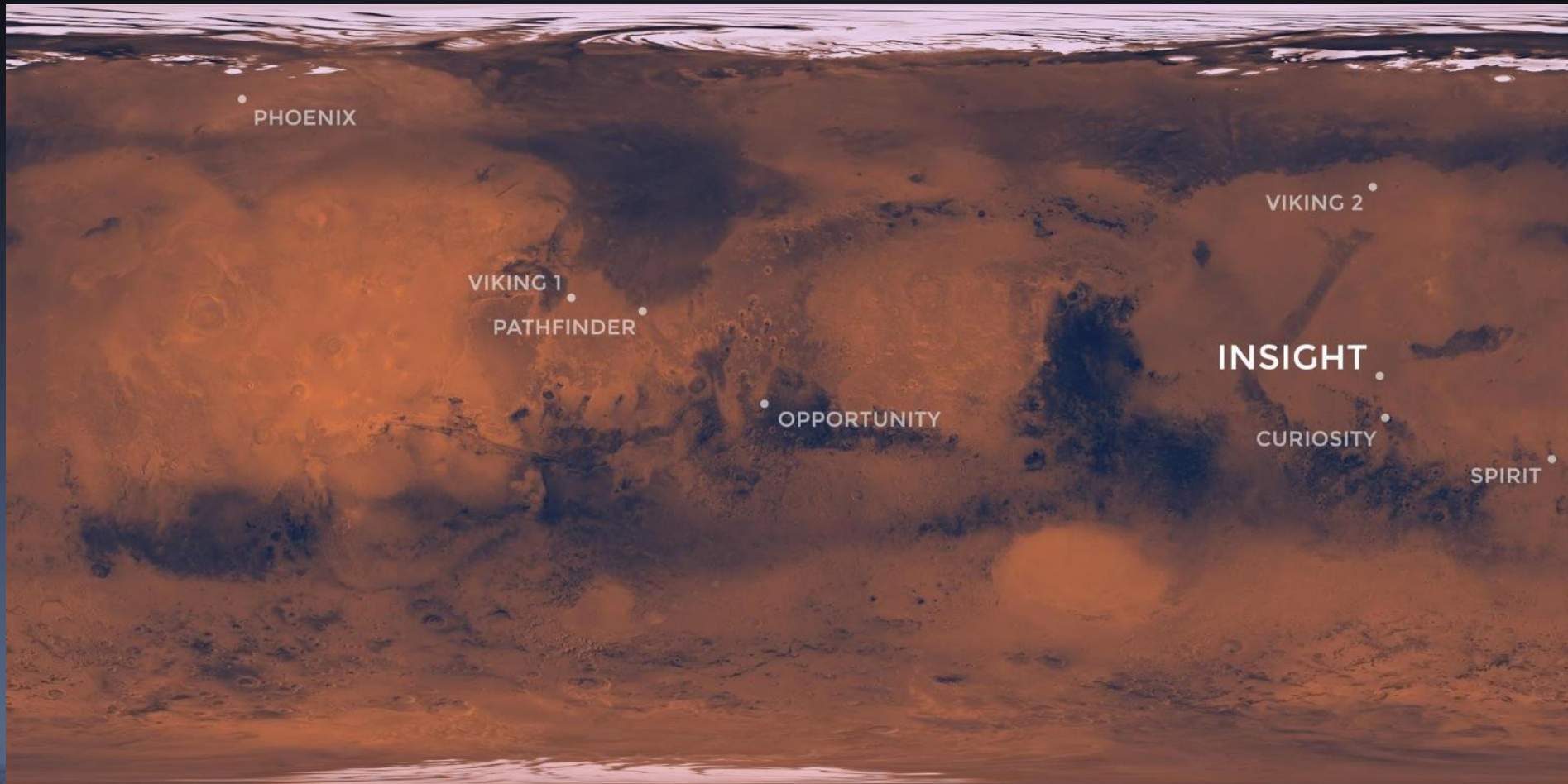
“seven minutes of terror”

**Surface Operations
2018 – 2020+**

- ☐ Checkout
- ☐ Deploy
- ☐ Calibrate
- ☐ Penetrate (HP³)
- ☐ Monitor

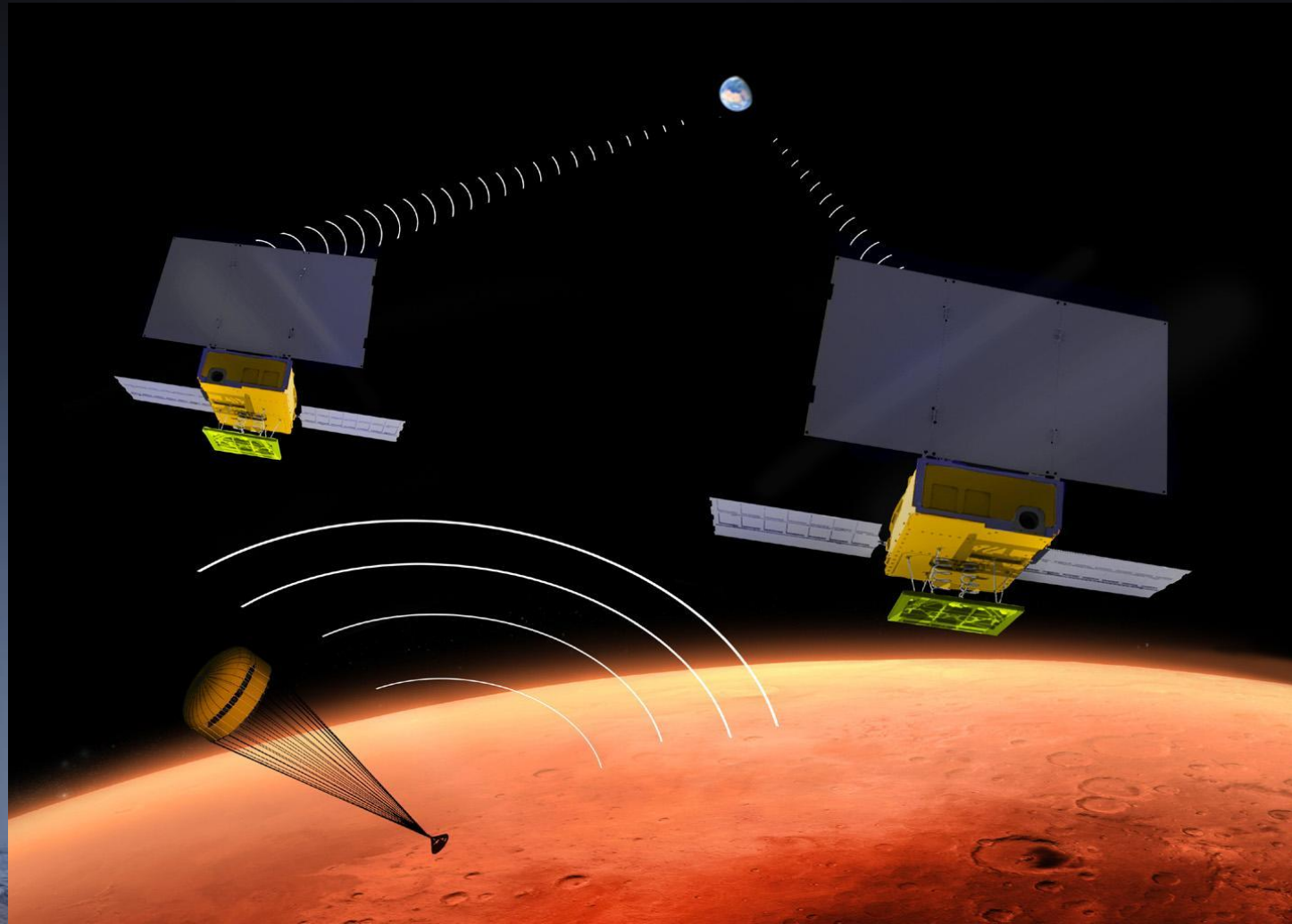
The spacecraft is almost ready for launch!

InSight will land at Elysium Planitia on November 26, 2018!



The landing site is a flat, smooth, largely rock-free plain with the right soil for HP³'s mole to dig.

Two Mars Cube One (MarCO) cubesats will fly with InSight to Mars.



They will witness InSight's landing.

The InSight Lander carries a chip with names submitted by the public.



2.4 million names will go to Mars aboard InSight!

InSight Roadshow!

We are going on the road and coming to a town near you!

Tour Stops:

March 30-April 1: Turtle Bay Exploration Park

March 30: Shasta Unified School District - David Marr Theater

April 13-15: Powerhouse Science Center

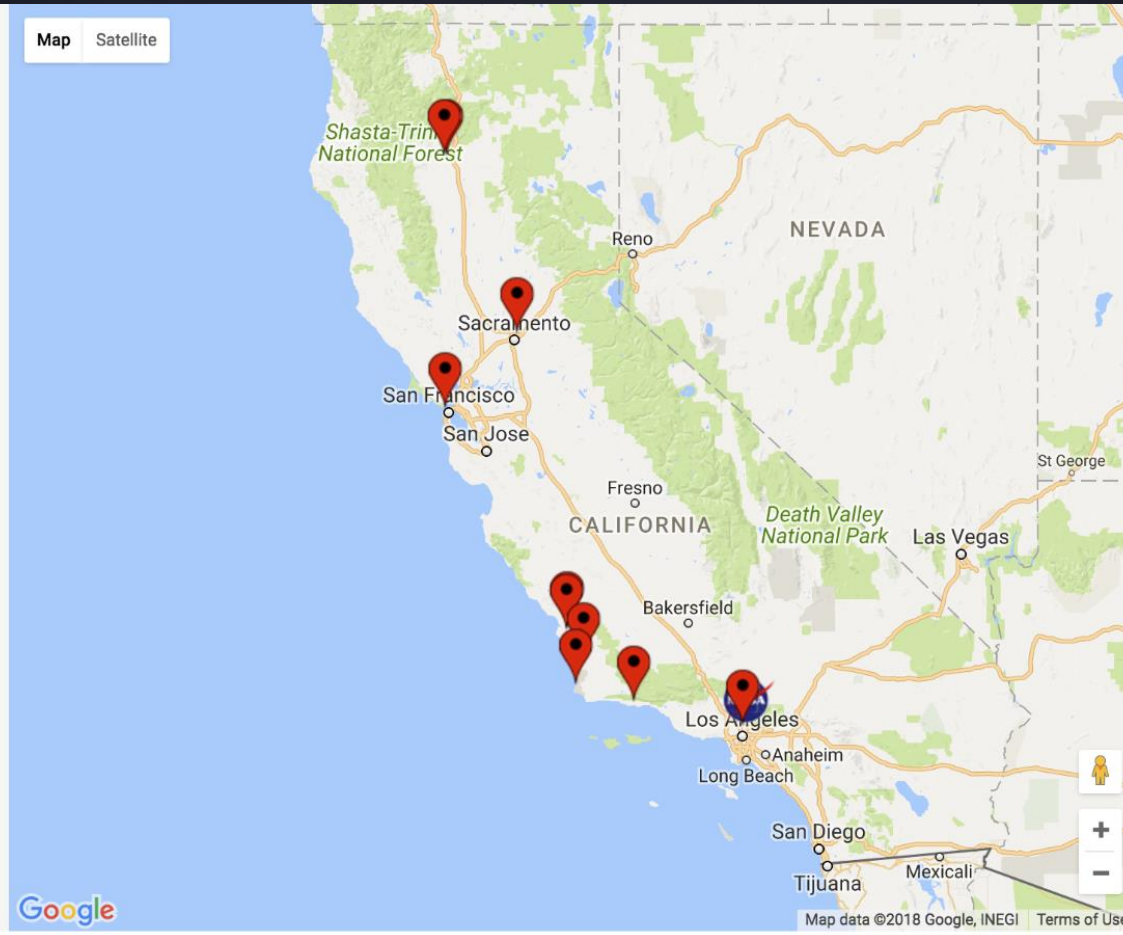
April 18-22: Exploratorium

April 27-29: San Luis Obispo Children's Museum

May 2-3: Santa Maria Valley Discovery Museum

May 3: Cal Poly San Luis Obispo

May 3: Lompoc Public Library - Grossman Gallery

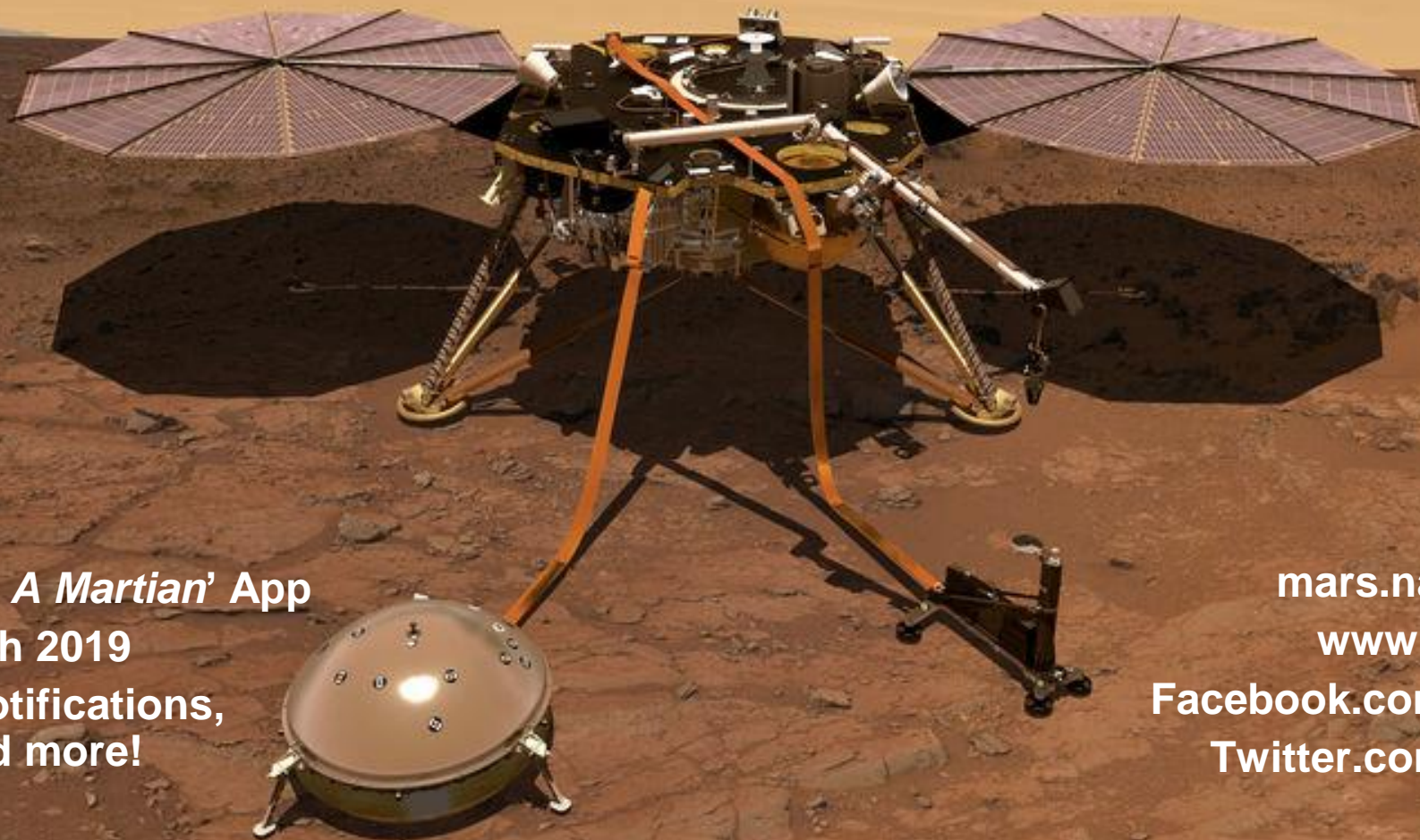


**Talk to
Scientists**

See Exhibits

**Make Your Own
Marsquake**

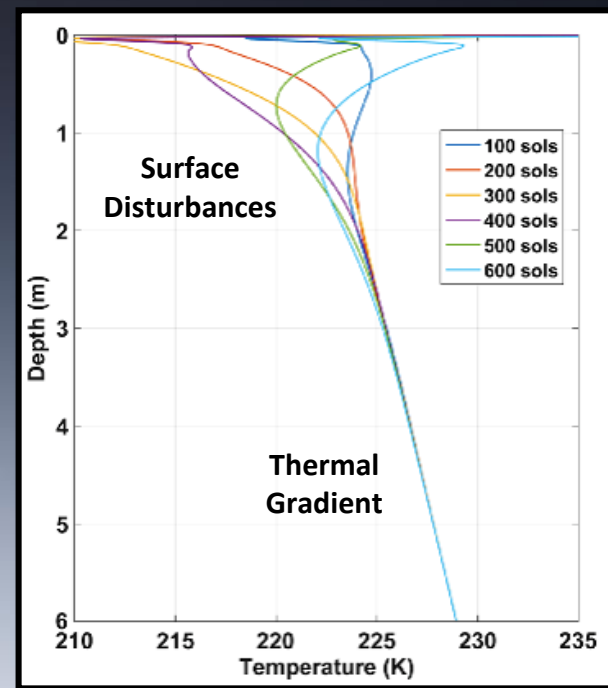
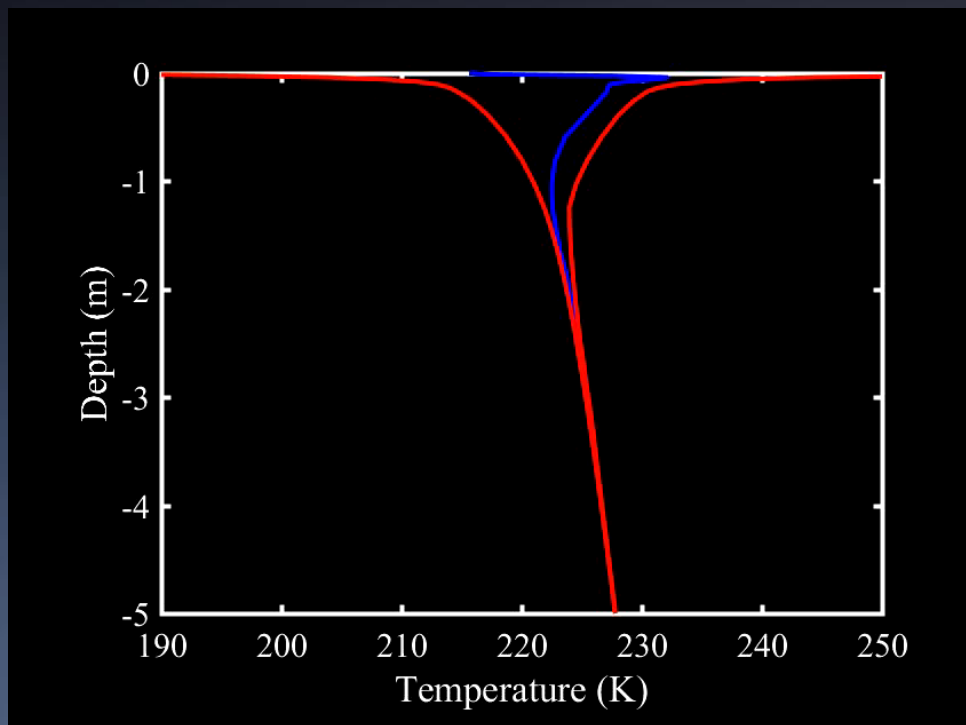
**Follow InSight on its Journey to Mars.
Watch the Launch Online!
Get notifications of MarsQuakes!**



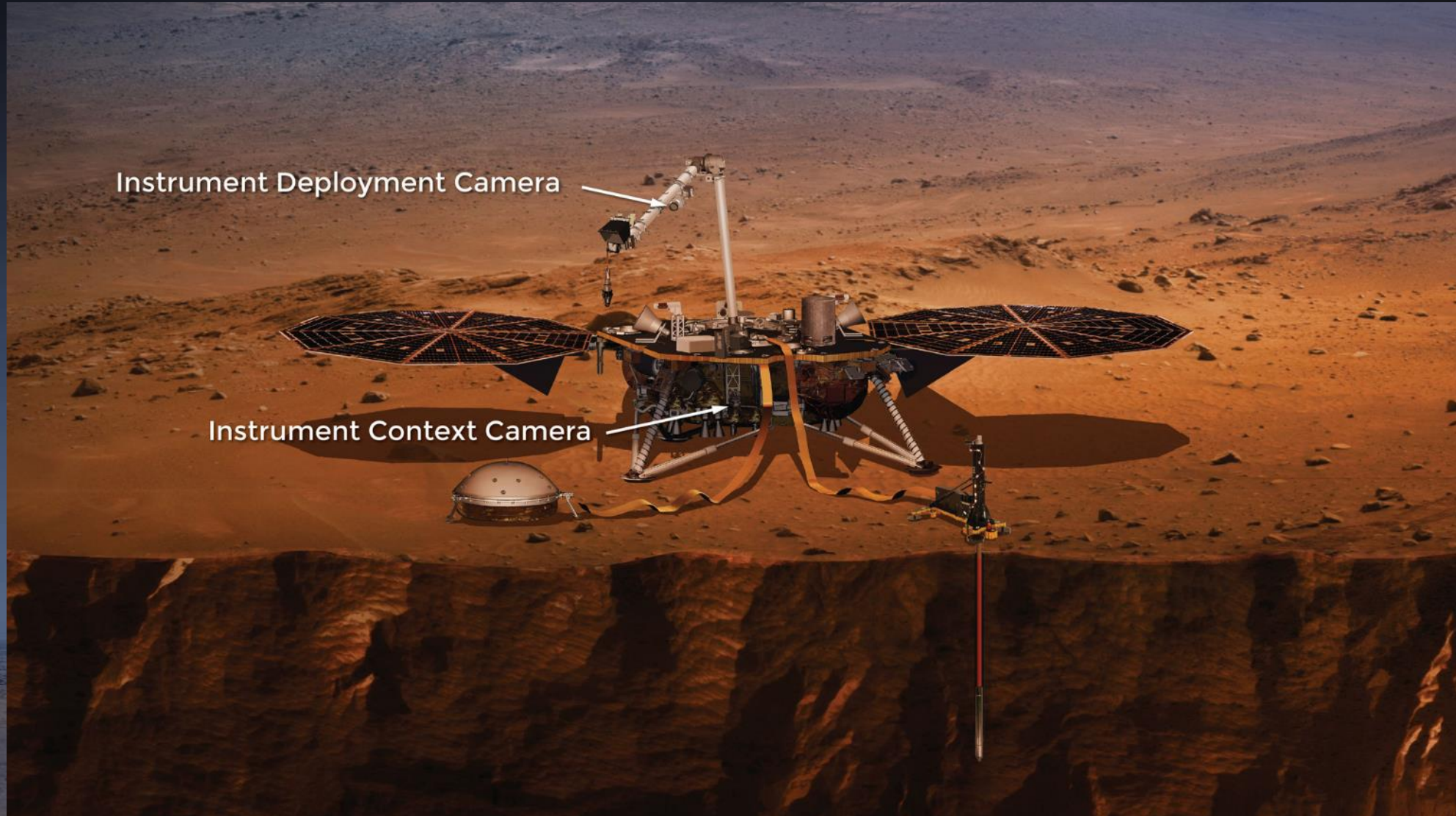
**Download the '*Be A Martian*' App
First Data in March 2019
Get Marsquake notifications,
Mars weather, and more!**

**mars.nasa.gov/insight
www.nasa.gov/mars
Facebook.com/NASAIInSight
Twitter.com/NASAIInSight**





**InSight has two color cameras,
which serve as the lander's eyes.**



In January, InSight stretched out its solar panels one last time before getting packed and shipped to the launch site.

